Effect of serial lower limb Botulinum toxin-A injections on gait quality in children with bilateral cerebral palsy

F.A. Read1, R.N. Boyd1, L.A. Barber1
1Queensland Cerebral Palsy and Rehabilitation Research Centre, The University of Queensland, Brisbane, Australia.

Background:
Serial lower limb intramuscular Botulinum toxin-A (BoNT-A) injections are administered to children with bilateral spastic motor type cerebral palsy (BCP) to temporarily reduce spasticity, improve walking and functional mobility and to delay the need for lower limb orthopaedic surgery. As part of standard clinical review, 2D video gait assessments are used to monitor change in walking quality following repeated BoNT-A treatment (Figure 1). The Edinburgh Visual Gait Score (EVGS) is a valid and reliable measure of gait quality in children with BCP.

Aim:
To retrospectively determine the longitudinal effect of serial lower limb intramuscular BoNT-A injections on gait quality in children with BCP and dynamic equinus.

Methods:
Mean passive dynamic ankle dorsiflexion range (knee extended) at baseline was left -19.6 (9.9)° and right -17.1 (11.0)°. The mean passive static ankle dorsiflexion range (knee extended) at baseline was left 4.5 (6.6)° and right 7.3 (6.7)°.

Participants had received lower limb intramuscular BoNT-A injections to a maximum total dose 4-6 U Botox®/kg body weight per muscle to the gastrocnemius and/or medial hamstrings muscles. Additional treatment: Serial casts (2-3 weeks) of the ankle to improve dorsiflexion were reported in 15 participants; ankle foot orthoses were reported in 14 participants; physiotherapy strengthening and mobility training sessions were reported in 13 participants.

The 2D gait videos were assessed by one rater using Edinburgh Visual Gait Score (EVGS). Biomechanical software (Kinovea, www.kinovea.org) was used to measure sagittal plane joint angles for classification of kinematics (Figure 2).

Mixed-effects linear regression assessed change from baseline to subsequent assessments. Independent t tests assessed change from pre- to post-BoNT-A in each treatment cycle (p<0.05).

Results:
There was a statistically significant reduction in EVGS scores from baseline to each subsequent assessment over three lower limb intramuscular BoNT-A injection treatment cycles (p<0.02). The greatest reduction in mean estimated EVGS score occurred between baseline and assessment 4 (difference = 2.76, p<0.01). There was a statistically significant reduction in EVGS scores from pre- to post-treatment assessments following the first BoNT-A injection (p=0.03) but not following the second or third BoNT-A injections (p>0.2).

Conclusion:
Gait quality as measured by the EVGS improved following the first lower limb intramuscular BoNT-A injection in children with BCP and dynamic equinus gait. Gait quality was maintained but did not improve over the second and third treatment cycles. The improvement in gait quality was statistically significant, but did not reach the least significant difference value of 3.2 points. Clinical significance needs to be considered in relation to treatment goals.

Figure 2: 2D video gait analysis images. (A) Frontal and sagittal view. (B) Maximum ankle dorsiflexion during terminal stance with angle overlay (using Kinovea). (C) Peak knee flexion during swing with angle overlay. (D) Peak hip flexion during swing with angle overlay.

Figure 3: Estimated mean EVGS score for the six assessment time points. BoNT-A treatment cycle 1 (Baseline to Ax 2, pink), cycle 2 (Ax 3 to Ax 4, green) and cycle 3 (Ax 5 to Ax 6, orange). *Significant improvement in mean EVGS score pre- to post-BoNT-A assessments in treatment cycle 1. **Significant improvement in mean EVGS score from baseline to all subsequent assessment points.

Figure 1. Schematic of three lower limb BoNT-A treatment cycles. Period from pre- to post-BoNT-A clinical review is ~12 weeks. One treatment cycle is ~8 months.